

Flexibility and Creativity in Microblade Core Manufacture in Southern Primorye, Far East Russia



TRUDY DOELMAN

IT IS WIDELY ACKNOWLEDGED THAT MICROBLADE TECHNOLOGY appeared after the LGM (around 18,000–16,000 B.P.) and dispersed across most of East and Central Asia (including Mongolia, northeast China, Korea, Japan, and Far East Russia) and then into northwest America during the late Pleistocene and early Holocene. It is argued that this distribution indicates the widespread adoption and spread of a technology that was effective in countering the problems of living in an extreme northern environment, in particular the harsh winters (Goebel 1999, 2002; Yesner and Pearson 2002:134). Understanding the reasons why this technology became so dominant is viewed as the next stage in microblade research, moving away from the descriptive approaches of their manufacture, typology, and cultural origin/ethnicity (Elston and Brantingham 2002:103; Seong 1998:245).

This paper explores the variation in core morphology appearing in assemblages from the Primorye region in the Russian Far East and argues that the typological approach does not account for all diversity in core preparation. Numerous contextual or “situational” variables such as the regional geology, the distance from the sources, and the form of the available material influenced how cores were prepared. The considerable flexibility and creativity in microblade core preparation indicates that the end products (i.e., microblades) were more important than how they were achieved. To understand the dominance of microblade technology in space and time the focus of investigation then turns to the microblades as these are directly employed to make weaponry to capture game: a vital risk-minimizing strategy.

THE COSTS AND BENEFITS OF MICROBLADE TECHNOLOGY

Microblades are produced from highly specialized, wedge-shaped cores and are thought to have been used as insets in composite tools (made from wood and

Trudy Doelman is a Postdoctoral Research Fellow in the Department of Archaeology, University of Sydney, Australia.

Asian Perspectives, Vol. 47, No. 2 © 2008 by the University of Hawai'i Press.

stone), such as projectile points for hunting weaponry (Elston and Brantingham 2002:104; Lu 1998). Microblades themselves are small, parallel-sided, elongated flakes with an average width of 5 mm (Odell 2004:96). Composite tools had the advantage over solely organic or stone tools as they maintained both the strong and lethal characteristics of each and lost the disadvantages of both (Elston and Brantingham 2002:105). For example, composite tools can be used many times, are durable, and can be easily fixed when broken thereby allowing for maximum performance. In this regard the use of microblades directly impacts on the ability to capture game and more importantly reduces the “risk” of failing to acquire subsistence resources. This technological approach is considered a risk-minimizing strategy that enabled continued survival in difficult environments (Elston 1990:154; Elston and Brantingham 2002; Torrence 1989:62–63).

The benefits of having this technology outweigh the costs involved in manufacturing microblades (Elston and Brantingham 2002:105–106). Additional costs in the manufacture of microblades include the time invested in obtaining suitable material, the time required to develop the skills to successfully manufacture microblades and the effort involved in hafting and replacing the microblades (Bamforth and Bleed 1997:130). Manufacturing failure can be reduced by knapping “batches” of microblades thereby lowering the costs of preparation and allowing for scheduling manufacture during “downtimes” (Bamforth and Bleed 1997:130). Producing batches of microblades may also lead to standardization in the size of the product. The advantage of having a standardized product is in creating a maintainable technological system whereby replaceable components operate in identical ways to each other. This system was termed “over-design” by Bleed (1986:739–740). Nelson (1991:70–71) further suggested that a maintainable design was either versatile or flexible. *Versatility* (or multi-functionality) allowed a tool to have a wide variety of different uses whereas *flexibility* required a tool’s form to change to meet a range of different uses.

First, this paper argues that both creativity, the ability to be highly innovative, and flexibility in microblade core preparation were effective strategies for reducing the risk of not having the required tool at the right time. Flexibility differs from Nelson’s (1991) definition and is referred to here as the ability to achieve a particular technological goal through various means. Second, it is suggested that examining standardization in the size of the cores and resulting microblades is an important measure for determining the importance of this technological strategy in reducing risk.

To begin, an overview of the more traditional typological approach to core variation in the region is presented.

CORE TYPOLOGY

Although there are many different core types used to make microblades (e.g., bullet or prismatic microblade cores) in northeast Asia and northwestern North America, the main focus of this paper is on the wedge-shaped or boat-shaped microblade cores. These cores are typically triangular in cross section, elongated and oval in shape with a flat striking platform. Opposite the platform there is often a bifacial edge or “keel” that gives the cores its distinctive wedge-shaped appearance. The characteristic shape of the core is presumably fashioned to

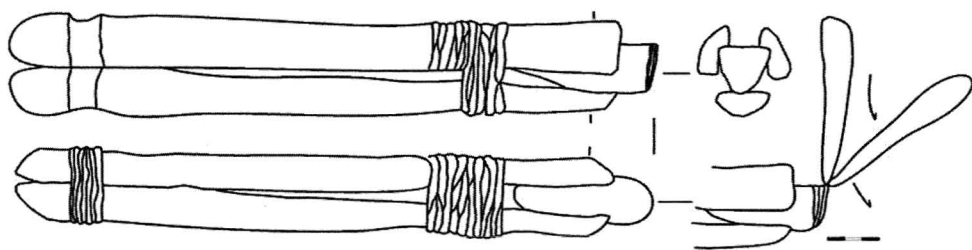


Fig. 1. Reconstruction of support apparatus used for microblade manufacture (adapted from diagram displayed at the Museum of Archaeology and Ethnography, Science Museum of the Far Eastern State University).

be inserted into a support apparatus which makes microblade removal easier (Andrefsky 1987:29–30). Figure 1 shows an example of the support apparatus hypothesized to be used in the Russian Far East for microblade production.

Kobayashi (1970:38–40) identified two separate techniques for the preparation of microblade cores in Japan. The first core type was made on an ovoid biface split longitudinally from the tip of the biface. A series of flakes (or ski spalls) were then removed to create a flat platform from which microblades were detached from one or both ends (Fig. 2). Sometimes the core was also trimmed along the lateral margins. This microblade core is termed the Yubetsu or Shirataki type and produces a core with a wedge-shaped profile. It is hypothesized here that the removal of a continuous series of ski spalls may be a way of creating the correct core size and profile to fit into the support apparatus.

The second core type identified by Kobayashi (1970:38–40) is made by splitting a pebble through the middle and shaping the lateral margins. The split surface becomes the platform and again microblades are removed from one or both ends. This is generally called the Horoko type and produces a boat-shaped core (Fig. 2).

Another core type that is widely recognized is the Togeshita type, which is made on a blade or unifacial point with a prepared lateral margin (Fig. 2). Blades are struck from one lateral margin to the opposite (Korotky et al. 2003:20).

Independent of the type, these cores all have a similar triangular cross section. It must be noted that the distinction between wedge-shaped or boat-shaped microblade cores is widely employed yet not “technologically or morphologically warranted but rather based on convention” (Seong 1998:249). Seong further noted (249) that many discrepancies in the typological approach also occur between Chinese, Korean, and Japanese archaeologists. For the purpose of this article a “wedge-shaped core” refers to both the wedge- and boat-shaped cores and the manufacturing techniques used to prepare the cores are distinguished.

Three scenarios have been proposed for the variation in microblade core typology. Bleed (2002:1001) has suggested that the microblade cores made on bifaces (e.g., Yubetsu type) served potentially three purposes—flake cores, axes, and lastly microblade cores. It is possible that this process indicates recycling, which maximizes the use-life and efficiency of the available stone. Elston and Brantingham (2002:107–112) argue that wedge-shaped cores are more cost-effective as they can produce microblades with a more standardized width and thickness, less lateral curvature and in greater numbers than the boat-shaped cores. As a result

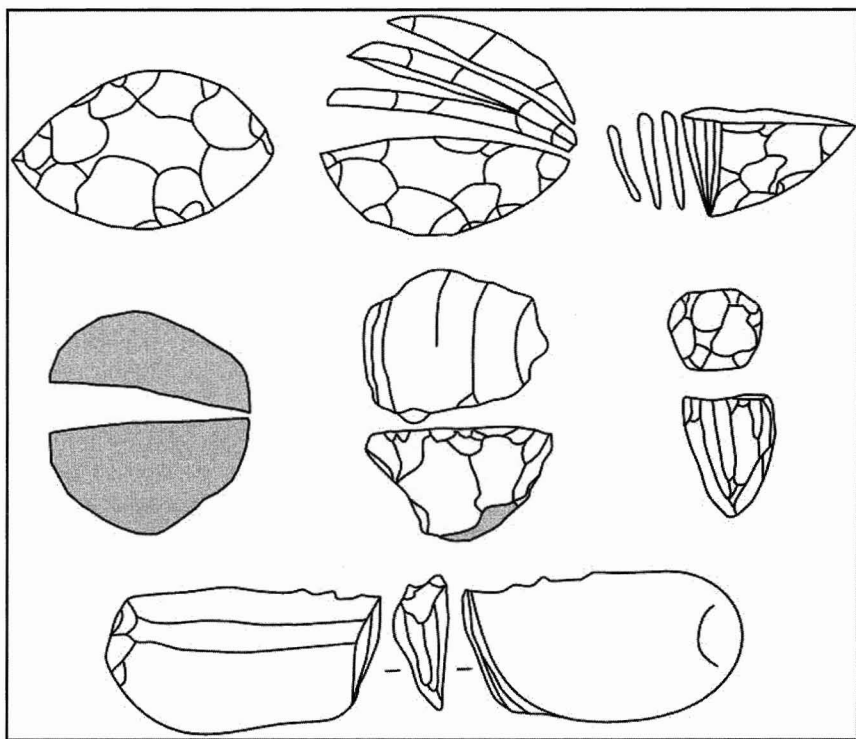


Fig. 2. Types of microblade cores found in north Asia. Yubetsu or Shirataki type (top); Horoko Type (middle); Togeshita type (bottom).

they consider the presence of wedge-shaped microblade cores as being an effective risk-reduction strategy (Elston and Brantingham 2002:109). Lastly, Seong (1998) maintains that spatial and technological variation in microblade core preparation may simply be due to raw material availability in northern, central and southern South Korea. How valid the use of these core types are, and why microblade manufacture occurs in particular ways is further explored here by focusing on microblade core preparation in the Russian Far East.

AN EXAMPLE FROM THE RUSSIAN FAR EAST

Cores and microblades from late Paleolithic sites in southern Primorye, Far East Russia, form the database for this study. A large number of different microblade core types, upwards of ten, have been proposed for the northeast Asian region but can be considered variations of the three types already described. In the Primorye region microblade cores similar to the Yubetsu, Horoko, and Togeshita types found in Japan were identified at the Ustinovka-6 site (Kononenko 2003:114).

The first step in this investigation is to characterize the volcanic glass sources and provide a sound geological context of the study area. This article then describes the ways microblade cores were prepared in the region. Lastly, the degree

of standardization in core size and the resulting microblades is examined to identify those key characteristics essential to their preparation and manufacture. The results are related to the costs and benefits of microblade technology, which are argued to be an adaptive approach employed to successfully live in, and colonize a challenging northern environment.

Source Characterization

It must be noted that a wide variety of different raw material types were used to make microblades in the Primorye region. However, this study focuses on those made from volcanic glass as this material type can be accurately sourced and used to identify the ways and distances artifacts resulting from microblade production were transported across the landscape.

Characterization studies of volcanic glass artifacts using PIXE-PIGME have provided excellent results discrimination among the sources used in the region (Doelman et al. 2004; Doelman et al. in press). These results compared favourably with the Instrumental Neutron Activation Analysis (INAA) previously undertaken by Kuzmin and Popov (2000:62–70; cf. Doelman et al. 2004: Table 3). In addition, tests of specific gravity have enabled large numbers of rhyolitic and basaltic glass artifacts to be successfully identified (Doelman et al. 2008). This approach was used to make an initial classification of the sources, which were then compared to the results of the PIXE-PIGME analysis. Overall, these results indicate that two sources were used for microblade technology in the Primorye region: local basaltic glass most likely originating from the Shkotovo Plateau and rhyolitic glass from the distant Paektusan Volcano located on the border of North Korea and China, 550–700 km southeast of the study area (Fig. 3).

A combination of the above approaches was used to source the 31 microblade cores and 136 blades from 11 late Paleolithic sites (Table 1 and Fig. 3). Only four of these cores originate from Paektusan Volcano, the remaining are basaltic in origin (Table 1). The cores from Paektusan are found at Ustinovka-6 and Risovaya-1 (Fig. 3). Most of the wedge-shaped cores are found in Molodeznaya-1 ($n = 9$, 29.0%) and Risovaya-1 ($n = 9$, 29.0%). A further 40 cores are either unfinished preforms or broken microblade core fragments. Only one fragment originated from Paektusan.

The fact that 32.4 percent ($n = 47$) of the total number of artifacts made from Paektusan obsidian were microblades, in comparison to the low number (6.6%, $n = 89$) of microblades made from basaltic glass, may indicate that blades were mostly transported as composite tools (Table 1). In addition to the presence of four wedge-shaped microblade cores, ridge-straightening flakes ($n = 4$) and crested blades ($n = 1$) were also made from Paektusan volcanic glass, indicating that at least some cores were being transported and continually worked.

Primary and Secondary Sources of Volcanic Glass

The geological distribution, quality, accessibility and abundance of stone influences the way people organized themselves in a particular environment (Bamforth 1992:131–133). For example, in an area rich in lithic resources with an abundance of high-quality material no limits are placed on manufacturing. Un-

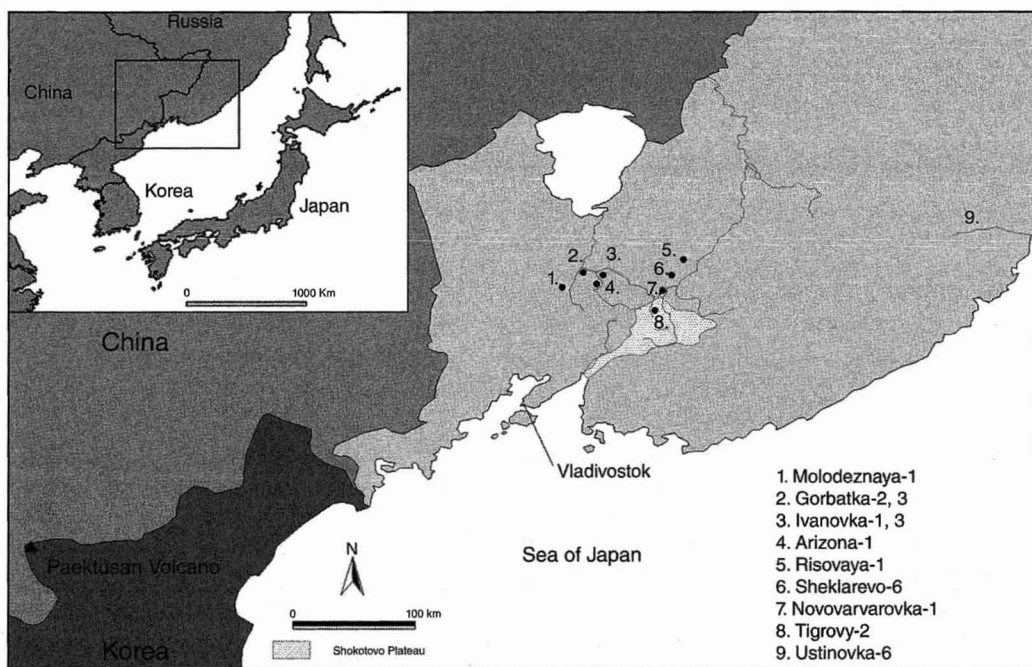


Fig. 3. Location of the volcanic glass sources and late Paleolithic sites in this study.

TABLE I. LATE PALEOLITHIC SITES IN THIS STUDY WITH WEDGE-SHAPED MICROBLADE AND MICROBLADES

SITE	BLADES		WEDGE-SHAPED MICROBLADE CORES	
	BASALTIC	PAEKTUSAN	BASALTIC	PAEKTUSAN
Arizona-1			1	
Gorbatka-2	2		2	
Gorbatka-3	5	3	1	
Ivanovka-1	2	1	2	
Ivanovka-3	1		3	
Molodeznaya-1	36	18	9	
Novovarvarovka-1	8	2	3	
Risovaya-1	17	19	6	3
Ustinovka-6				1
Sheklarevo-6	17	4		
Tigrov-2	1			
Subtotal	89	47	27	4
Total assemblage	Basaltic = 1355		Paektusan = 145	

TABLE 2. THE TYPE OF CORTEX FOUND ON THE WEDGE-SHAPED MICROBLADE CORES OF BASALTIC GLASS

CORTEX TYPE	BASALTIC	PAEKTUSAN
0%	8	4
Outcrop	4	1
Water-rolled	15	

derstanding the variability in the geological distribution and physical properties of the available raw material sources plays an important role in any technological study of lithic material (Tykot 2003:63). Hence, the manufacture, use, and distribution of the wedge-shaped microblade core may be influenced by the geological context and this will now be discussed.

Sources of volcanic glass are present within two geological contexts in the Primorye region and are defined here as primary and secondary; however it must also be noted that many of the cores have no cortex and may be from either source (Table 2). A primary source type occurs as an outcropping, in situ exposure whereas a secondary source is composed of material eroded from a primary exposure and transported downstream or reworked as beach deposits. The distance transported downstream from the primary source plays an important role in determining the size of the available cobbles and pebbles. The results of a geoarchaeological survey show that large cobbles, greater than 10 cm in length, were found in rivers and streams near outcrops in the Shkotovo plateau, whereas at 30–35 km away from the outcrops only small pebbles, generally less than 4 cm in length, were present in the Ilistaya River, a large river that drains from the Shkotovo Plateau (Figure 3; Doelman et al. 2008).

Variability in past practices is the result of “situational not categorical” human behavior (Elston and Brantingham 2002:103). Consequently, variation in core morphology may also be partly a product of the form in which material was available. This factor suggests the need to be flexible in preparing microblade cores was dictated by the use of small, local stream or river cobbles. Most of the microblade cores have a water-rolled cortex (from a secondary source) indicating that they were made on split pebbles obtained from a stream or river system (Table 2). The use of locally available small pebbles is similar to the situation found at the Fukai site in North Kyushu, Japan (Bleed 2002:97–98). At this site small nodules of volcanic glass were also used to make microblade cores. It must be acknowledged that the diversity of core types made from basaltic glass in Primorye may therefore be influenced by the form of the available material.

Diversity of Core Types

A wide variety of different cores types were found in the sites that form this study (Table 3). In particular, the presence of a diverse range of cores made from basaltic glass indicates that the flakes produced from these cores served a wider range of purposes and that cores were expediently used if sites were located close to suitable sources (Fig. 4). In contrast, most of the cores made from rhyolitic (i.e.,

TABLE 3. THE DIVERSITY OF CORE TYPES FOUND IN THE LATE PALEOLITHIC SITES

CORE TYPE	BASALTIC		PAEKTUSAN	
	COUNT	%	COUNT	%
Bi-directional	16	5.4		
Bifacial	33	11.1		
Bipolar	34	11.4	1	9.1
Bullet	2	0.7	2	18.2
Microblade	40	13.5	7	63.6
Multi-directional	39	13.1		
Prismatic	1	0.3		
Sub-prismatic	4	1.3		
Tabular	1	0.3		
Test	8	2.7		
Uni-directional	119	40.1	1	9.1
Total	297		11	

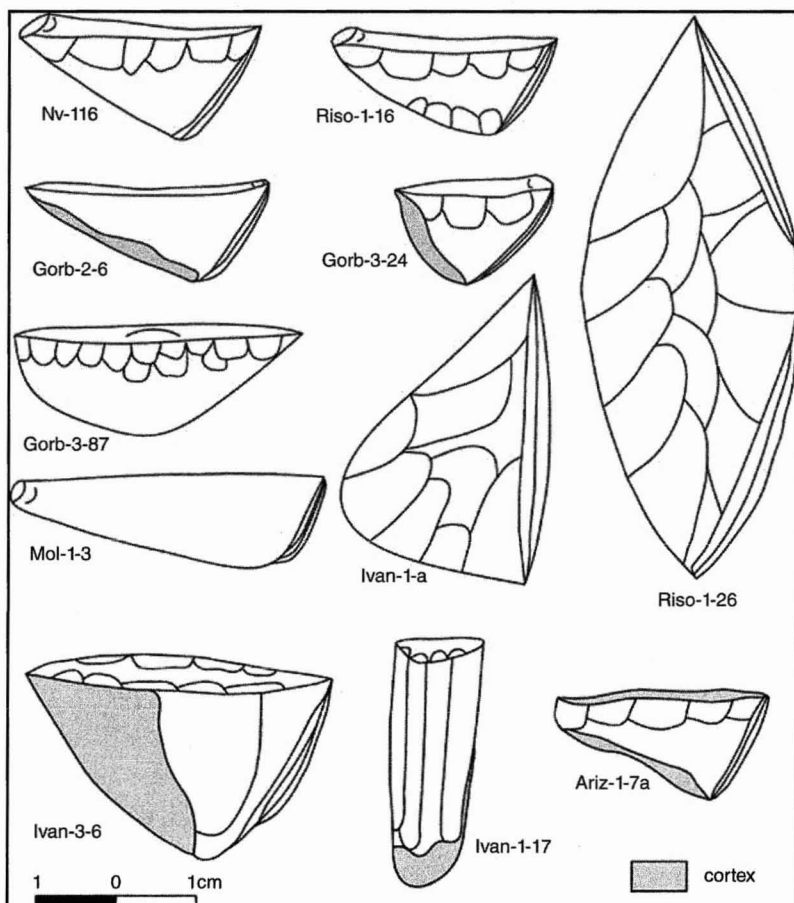


Fig. 4. Core preparation techniques employed in late Paleolithic sites, Southern Primorye.

Paektusan) glass are related to microblade production and are either wedge-shaped microblade cores or bullet cores (Table 3).

Almost all of the late Paleolithic sites in this study are located near the Shkotovo Plateau in Central Primorye (Fig. 3). It must be noted that these sites fall within a 60 km radius of outcropping sources of basaltic glass and are close to (<2 km) rivers with small, reworked, highly water-rolled pebbles of basaltic glass. The only exception is Ustinovka-6, which is c. 230 km from the Shkotovo plateau and c. 700 km from Paektusan (Fig. 3). Only one site in Central Primorye (Risovaya-1) has three microblade cores from Paektusan Volcano, a distance of roughly 450 km from the source (Fig. 3).

The distance from the source and availability of the material played a role in the types of cores produced. This pattern may have been caused by the selection and transportation of microblade cores or the inflexibility of the available material (local river pebbles) to produce other core types, due to their small size.

The Preparation of Microblade Cores

The following section focuses on the range of variability seen in the preparation of microblade cores from late Paleolithic sites in Central Primorye. These strategies reflect how creativity and flexibility were needed to use the available local sources. Although most of the microblade cores are typically wedge-shaped, two other forms have been observed: bullet cores and conical, prismatic microblade cores.

Core Preparation Strategy 1 — This core preparation strategy is made on a complete flake with an overshoot or plunging termination. It is likely that this termination type was produced on purpose to provide a longer core face for blade removals. Blades were detached from the ventral surface at the distal end of the flake. Overhang removal, indicating platform preparation, is sometimes observed along the core face. In a number of cases (e.g., Nv-116 in Fig. 4) the lateral margins of the flake were trimmed from the ventral surface reducing the overall width of the core. In this way the typical wedge-shaped profile was created. This profile was also achieved by creating a bifacial keel on the dorsal surface of the flake, sometimes (but not always) occurring in conjunction with the trimming of the lateral margin (e.g., Riso-1-16 in Fig. 4). These cores were not initially bifaces that were reworked as cores. Most of these cores were made on split cobbles. Those with shaped lateral margins and a bifacial keel represent the Horoko type.

Sometimes cores were not prepared in any way (e.g., Gorb-2-6 in Fig. 4). Often these cores have a “natural” keel of highly, water-rolled cortex indicating that stream cobbles were flaked (or split) using a bipolar technique to manufacture the flake blank used for microblade cores. This method was also observed by Smith (1974:350–351) in his description of the northeast Asian–northwest America microblade tradition.

In other cases the large flakes have no cortex, such as the cores at Novovarvarovka-1. It is likely that these cores were made from larger blocks or cobbles, not local stream pebbles, possibly originating from quarried sources. The presence of angular, irregular cortex on the surface of some cores indicates that outcrops were used as a source.

Core Preparation Strategy 2 — A core type similar to Strategy 1 has the proximal end used as a platform for the manufacture of blades. The flake is also produced from splitting a small cobble or pebble. The resulting flake has a thick proximal end which tapers toward the distal end making only the proximal end suitable for blade manufacture. Sometimes the platform was completely removed to prepare the striking platform (e.g., Gorb-3-24 in Fig. 4). This strategy is a variation of the Horoko type as they are both made by splitting a pebble or cobble using a bipolar technique. These cobbles/pebbles tend to have a highly water-rolled cortex. The cortex is usually on the base of the core and again forms a natural keel. Sometimes the lateral margin of the flake has also been shaped to form the typical triangular cross section of the wedge-shaped cores.

Core Preparation Strategy 3 — An unusual core preparation strategy occurs when the split cobble is rotated 90 degrees so that the original flake platform becomes the side of the core. The ventral surface of the flake was prepared, flattened with numerous flake removals to become the core platform, and the original flake platform removed. An unsuccessful attempt to do this is Gorb-3-87 where numerous flakes with step terminations were removed in an attempt to create the flake platform (Fig. 4).

Core Preparation Strategy 4 — Sometimes a microblade core is made on the distal end of an elongated complete flake. The termination was removed, fashioned into a platform, and blades detached along the lateral margin toward the platform. This microblade core is similar to the Hirosato type where large blades were used as blanks to remove microblades across the face of the flake (Seong 1998:250). Another version of this strategy uses one lateral margin as the keel and the other as a platform so that the blades extend across the entire width of the flake (e.g., Mol-1-3 in Fig. 4). Sometimes the platform is prepared. This core preparation strategy has been termed the Togeshita type. A number of highly weathered flakes were reworked (recycled) with evidence of more recent, "fresh" blade removals.

Core Preparation Strategy 5 — A bullet core (Monijiyama or Okedo type) typically has an elongated, cylindrical appearance (Kajiwara and Yokoyama 2003:22–23). The original core body is usually a block. In the two cases observed in southern Primorye the cores still retain some of the highly rounded water-rolled cortex indicating that they were made from stream/river pebbles (e.g., Ivan-1-17 in Fig. 4).

Core Preparation Strategy 6 — There are two examples of microblade cores that were made from naturally occurring slabs of volcanic glass (e.g., Ariz-1-7a in Fig. 4). The cores were shaped along the lateral margins in the same way as the Horoko type cores are and blades were removed from the thicker end.

Core Preparation Strategy 7 — The last strategy observed is similar to the Yubetsu or Shirataki type seen in Figure 2. Only two examples of this type were observed. One core was made from Paektusan volcanic glass (Riso-1-26 in Fig. 4) and the other from local basaltic glass (Ivan-1-a in Fig. 4). It seems likely, due to its shape, that Riso-1-26 was made from a reworked bifacial point (Fig. 4) whereas Ivan-1-

a may have been made from a bifacial knife. It is impossible to tell if the ovoid biface was made deliberately as a blank for a microblade core.

Core Preparation Strategy 8 — To extend the use-life sometimes the core was rotated 180 degrees and blades were removed from both ends (the proximal and distal ends of the flake blank). This rotation in turn produces a sub-prismatic to prismatic core profile.

In summary, considerable variation can be observed in how microblade cores were prepared. As these observations make clear there is a wide variety of core preparation techniques. How similar these core types are metrically will now be investigated.

Standardization in Core Size

If we ignore how cores were actually prepared and simply look at their form at discard what variation occurs in their size? The prediction is that the knappers required a particular cross section and were not interested in how this was achieved. Standardization should be seen in the core dimensions especially if the size was dictated to some extent by the support apparatus. Standardization should also be seen in the size of the microblades as these are considered replacement parts. Figure 5 shows the location of the size dimensions recorded on the wedge-shaped microblade cores.

A comparison of the size and weight of the wedge-shaped microblade cores made from basaltic glass and rhyolitic glass from Paektusan indicates that overall the cores from Paektusan are larger and heavier while the scar width is smaller (Table 4). One core from Paektusan biases the results by creating a large standard deviation in the length and weight measurements. This core (Riso-1-26 in Fig. 4) is made on a reworked biface and has two platforms at opposite ends. Potentially, the entire core face (72 mm) could have been used but this was not the case as only microblades with a greatest maximum length of 41 mm were removed (Fig. 4).

A simple series of plots shows the relationship between the different core dimensions measured (Fig. 6). Standardization in some of the core dimensions can be observed. For example, as the length of the core increases in Figure 6 the thickness of the core does not. Equally as the thickness increases the core face

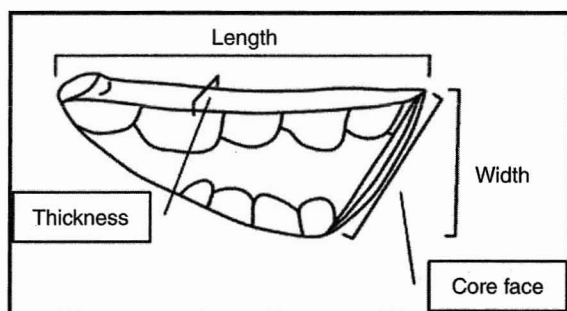


Fig. 5. Dimensions measured on the wedge-shaped microblade cores.

TABLE 4. SIZE AND WEIGHT OF THE MICROBLADE CORES IN SOUTHERN PRIMORYE

DIMENSIONS (mm)	SOURCE	BASALTIC	PAEKTUSAN
Length	Mean	28.7	37.1
	STD	7.0	14.0
Width	Mean	17.5	19.3
	STD	5.8	4.3
Thickness	Mean	10.9	9.7
	STD	2.7	3.4
Core face	Mean	18.6	27.4
	STD	8.0	19.9
Scar length	Mean	17.9	23.0
	STD	6.9	8.5
Scar width	Mean	4.1	3.6
	STD	1.0	1.0
Weight (g)	Mean	6.9	9.2
	STD	4.5	9.6

does not (refer to Fig. 5 for the dimensions measured). A similar pattern can be seen in the length and core face. In contrast, the width (or height) of the core varies, but generally increases with the length of the core as does the core face. The R values, seen in Figure 6, show the correlation between each of the values measured and these can be ranked from a high correlation to a much lower correlation. (1: width/core face, $R = 0.654$; 2: length/width, $R = 0.559$; 3: width/thickness, $R = 0.402$; 4: length/core face, $R = 0.308$; 5: length/thickness, $R = 0.188$; 6: thickness/core face, $R = 0.162$).

The results show that it is better to have an elongated core with a longer core face in order to produce longer blades. However, it must be remembered that blade manufacture is a reductive process that will influence the length of the core more than any other variable. The core thickness is the most important dimension as this is the most standardized. This result may be related to the type of support apparatus used during blade removals and may be directly linked to the amount of lateral trimming undertaken on a core. Cores may well have been trimmed simply to reduce the width as dictated by the manufacturing process.

Standardization in Blade Size

The next step is to identify whether standardization can be seen in the products of microblade production. The previous investigation of the core typology and dimensions shows that very little standardization can be seen in the microblade cores. Three aspects of microblade production will now be examined: the differences in the sources used; differences in the patterns of fragmentation; and the dimensions of the microblades.

A comparison of the degree of fragmentation of the microblades made from basaltic and rhyolitic glass shows interesting differences, which may be related to the manufacturing and discard processes. Most of the microblades from Paektusan

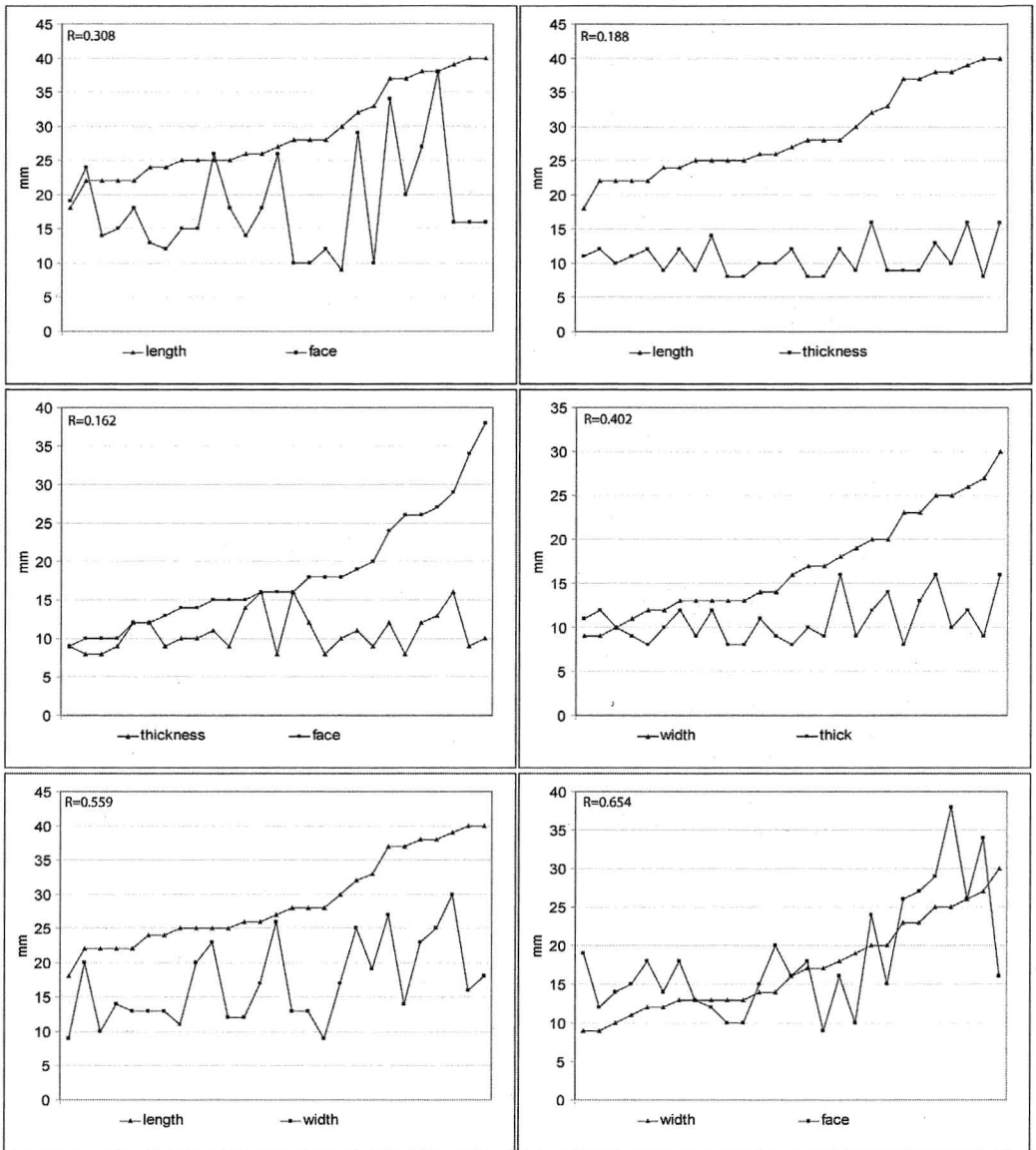


Fig. 6. Comparison of dimensions for wedge-shaped microblade cores in Southern Primorye.

were broken as either medial or proximal fragments (Table 5). These results suggest that the broken microblades from Paektusan were purposefully snapped to become part of composite tools and then transported. In contrast, more of the basaltic glass microblades are complete, which may indicate that a variety of discard processes were used (Table 5). It is likely that these processes include manufacturing breakages, the abandonment of unsuitable complete flakes, as well as the discard or loss of utilized microblades. As previously noted, cores from Paektusan were also worked and rejuvenated but most of the evidence of microblade manu-

TABLE 5. FRAGMENTATION OF THE MICROBLADES MADE FROM BASALTIC AND RHYOLITIC GLASS IN THE LATE PALEOLITHIC SITES OF SOUTHERN PRIMORYE

FRAGMENTATION	BASALTIC		PAEKTUSAN	
	COUNT	%	COUNT	%
Medial	18	20.2	19	40.4
Distal	16	18.0	4	8.5
Proximal	26	29.2	18	38.3
Complete	29	32.6	6	12.8
Total	89		47	

facture is the microblades themselves. A relatively high proportion of the microblades came from the distant source of Paektusan in comparison to those made from basaltic glass (2:1). This result suggests that microblades which formed parts of composite tools had a long use-life and were indeed reliable and durable.

Differences in the dimensions of the microblades made from basaltic and rhyolitic glass can be observed in the late Paleolithic sites (Table 6). The microblades from Paektusan are much smaller in width and thickness than those made from basaltic glass (Fig. 7). The thickness of the microblades made from Paektusan obsidian is significantly smaller than those made from basaltic glass ($t = 5.072$, $df = 134$, $p < 0.0001$) and the width is almost significant ($t = 1.869$, $df = 134$, $p = 0.0638$). These results suggest that there was an economy in the use of microblade cores from Paektusan. The careful and controlled working of the cores indicates that the numbers of microblades produced from each core was maximized.

The maximum length and width of the flake scar on the microblade cores shows the size of the microblades produced. The maximum length of the scars on the microblade cores is 23.9 mm with a maximum width of 5.3 mm. The mean size of the microblades made from basaltic and rhyolitic glass fall within this range (Table 6). The blade length is more variable than the width and thickness shown by the standard deviation. These results indicate that there is more variability in the length of the microblades produced than the width and thickness. It is likely that the width and thickness was dictated to some extent by the inset of the composite tool.

TABLE 6. DIMENSIONS OF THE MICROBLADES MADE FROM BASALTIC AND RHYOLITIC GLASS IN THE LATE PALEOLITHIC SITES OF SOUTHERN PRIMORYE

mm		BASALTIC	PAEKTUSAN
Length	Mean	18.6	17.6
	STD	6.6	6.0
Width	Mean	7.2	6.1
	STD	3.6	2.5
Thickness	Mean	2.1	1.1
	STD	1.3	0.5

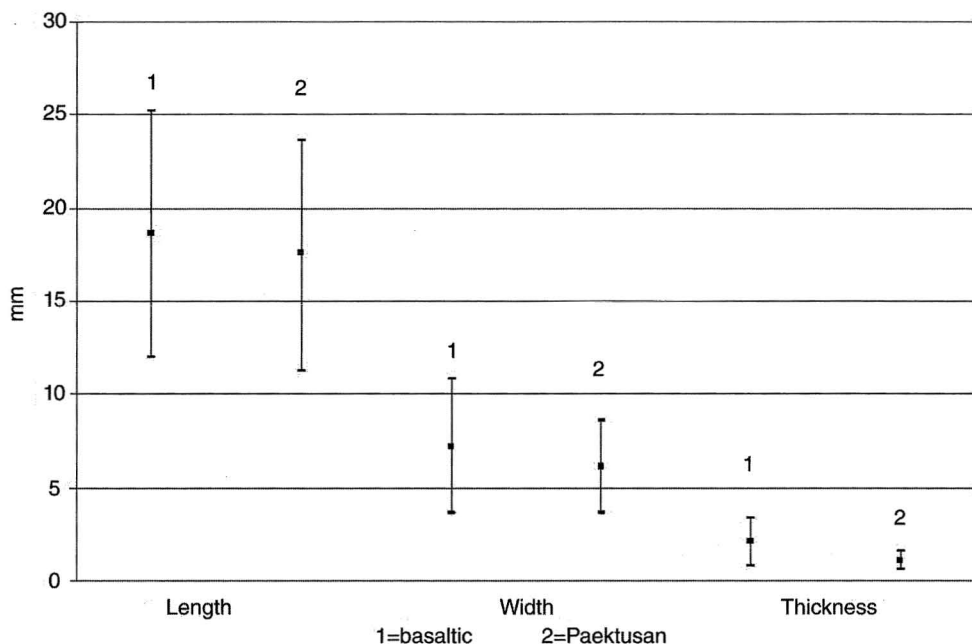


Fig. 7. Mean and standard deviation of microblade dimensions made from basaltic and Paektusan volcanic glass.

DISCUSSION

The article shows that considerable flexibility and creativity occurs in microblade core preparation. It argues that wedge-shaped microblade cores were made in a variety of ways in the Russian Far East that were influenced by the size and form of the available material and the distance from the source. Furthermore, flexibility in the preparation of microblade cores was needed to maximize the flaking potential of the small river/creek cobbles or fragments. The desire to have microblades has driven this approach to wedge-shaped microblade core preparation. As these observations make clear although many core preparation techniques were used, essentially the core type is the same and the end products (e.g., microblades) were more important than how this was achieved. Furthermore, the amount of core preparation (lateral trimming and the manufacture of a bifacial keel) may simply be due to the need to *fit* the core into the support apparatus. The use of a purely typological approach would have obscured the variation observed in core morphology of the Russian Far East.

Flexibility in wedge-shaped microblade cores is also seen in the presence of reworked bifacial points and knives. Although bifaces were used as preforms for the preparation of Yubetsu type cores (Kobayashi 1970:47) their presence is more indicative of the recycling which extends the use-life of the available material. This feature of an assemblage was also observed by Bamforth and Bleed (1997:1310) who believed that bifaces, once past their usefulness, were then recycled thus reducing procurement costs. Recycling is also seen in the appear-

ance of wedge-shaped cores made on old, weathered flakes. The need to maximize the use of the available material in whatever size or form is also observed in the 180-degree rotation of the core to remove blades from both ends (the proximal and distal ends of the flake blank) to produce a subprismatic to prismatic core profile.

Only a limited degree of standardization was observed for the wedge-shaped microblade cores. The most important dimension was the thickness and this was probably dictated by the support apparatus. Similarly, the length of the microblade is less important (and can be more variable) than the width and thickness since these latter dimensions are influenced by the haft of the composite tool. Ideally longer blades would be produced as these can be snapped to fit any size gap as replacement parts or used to complete a new tool. This approach creates a maintainable technological system as defined by Bleed (1986:739–740). However, there is some variation in the size of the microblades made from basaltic glass compared to those from rhyolitic glass, which may be a factor of distance from the source. Microblades from the distant Paektusan Volcano, made from rhyolitic glass, are significantly smaller in thickness than their basaltic counterparts. There are several reasons for this: wedge-shaped microblade cores from Paektusan were knapped more economically; or the basaltic microblades resulted from a variety of discard approaches including the abandonment of unsuitably sized blades that biased the results; and the selection and transportation of suitable microblades made from Paektusan volcanic glass. All these factors are important when considering the range of diversity in microblade production. As a result, it is unlikely, as Bleed (2002) suggests, that the differences in size in northern and southern Japan between the two manufacturing techniques that Kobayashi (1970) originally identified are simply related to the ecological context and the types of hunting strategies employed.

These features of the microblade assemblages of Far East Russia highlight the need for hunter-gatherers to be flexible in their technology to achieve their subsistence goals. Ultimately the goal was to increase the chances of surviving in a difficult environment with extreme seasonal changes by acquiring resources when needed. Microblade technology allows hunting weaponry to operate effectively and be easily maintained for ready use. This paper emphasizes the importance of being adaptable in microblade core preparation to obtain a particular goal, a microblade, through a variety of ways. A characteristic of hunter-gatherer populations now more fully acknowledged is the ability to be flexible in achieving subsistence goals (Bowdler 2002; Junker 2002; Morrison 2002). This hints at the importance of being constantly innovative as a risk-management strategy to counter social and environmental problems. Hence, it is likely that hunter-gatherer behavior in the past was always in a state of flux, continuously changing and adapting. This ability may be the key to why hunter-gatherers could successfully and relatively quickly colonize large areas of East and Central Asia and into the Americas.

CONCLUSION

To better understand the reasons behind the florescence of microblade technology in the late Paleolithic it is important to firstly determine the context of

microblade production. A geoarchaeological survey of the available lithic resources in combination with sourcing studies has added to our understanding of how microblade cores were prepared and what was transported around the landscape.

It is argued that the aim of microblade core technology was to efficiently produce large numbers of microblades that were also as long as possible. To do this the cores were prepared to fit into the support apparatus—a process employing a wide variety of core preparation techniques. To some extent these techniques were influenced by the restricted size and form of the locally available material as only small cobbles/pebbles are found near the sites in the Central Primorye region. In this way creativity and flexibility in core preparation are vital to being able to use this resource. Conversely, in an area with plentiful, good quality material where no restrictions are placed on manufacturing, potentially more standardized types may be found.

Having such a flexible and creative approach to the preparation of the microblade cores reduces the risk of not having a functioning tool at the required time, thereby creating a highly successful adaptive approach. This type of technological organization provides the possibility and ability to live in and colonize new, often difficult, parts of the landscape. Hiscock (1994) considered this factor important in the occupation of the arid zone landscape during the mid-Holocene in Australia. By teasing apart the many factors that contribute to the variability of microblade technology it is possible to gain a better understanding of how they were manufactured and why differences in assemblages occur.

ACKNOWLEDGMENTS

This research was supported by an Australian Research Council Discovery grant to Torrence, Kononenko, and Doelman and AINSE grants to Torrence and Doelman. An international team of archaeologists and geologists aided in the collection of some of the geological samples for this study in October 2001, including Dr. Vladimir Popov (Far East Geological Institute, Vladivostok), Dr. Y. Yoshitani (Tottori University), T. Tomodo (Hokkaido), and J. Cassidy (University of California at Santa Barbara). At the Australian Museum specific density testing was assisted by Ian Graham, Gayle Webb, and Ross Pogson from the Geoscience Department and Peter White (University of Sydney). This work was supported by archaeologists at the Institute of History, Archaeology and Ethnography in Vladivostok. In particular I wish to thank N. Kluyev, I. Sleptsov, and I. Pantyukhina. Many thanks to the staff at the Museum of Archaeology and Ethnology, Far Eastern State University in Vladivostok, for permission to photograph the displays. I wish to thank Peter White and Fiona Petchey for helpful comments and suggestions.

REFERENCES CITED

- ANDREFSKY, WILLIAM, JR.
 1987 Diffusion and innovation from the perspective of wedge shaped cores in Alaska and Japan, in *The Organization of Core Technology*: 13–43, ed. J. K. Johnson and C. A. Morrow. Boulder: Westview Press.
- BAMFORTH, DOUGLAS B.
 1992 Quarries in context: a regional perspective on lithic procurement, in *Stone Tool Procurement, Production and Distribution in California Prehistory*: 131–150, ed. J. E. Arnold. Los Angeles: Institute of Archaeology, University of California.

BAMFORTH, DOUGLAS B., AND PETER BLEED

- 1997 Technology, flaked stone technology, and risk, in *Rediscovering Darwin: Evolutionary Theory and Archaeological Explanation*: 109–139, ed. C. M. Barton and G. A. Clark. Arlington: Archaeological Papers of the American Anthropological Association No. 7, American Anthropological Association.

BLEED, PETER

- 1986 The optimal design for hunting weapons: Maintainability or reliability. *American Antiquity* 51:737–747.
- 2002 Cheap, regular and reliable: Implications of design variables in Late Pleistocene Japanese microblade technology, in *Thinking Small: Global Perspectives on Microlithization*: 97–102, ed. R. G. Elston and S. L. Kuhn. Arlington: Archaeological Papers of the American Anthropological Association No. 12, American Anthropological Association.

BOWDLER, SANDRA

- 2002 Hunters and traders in northern Australia, in *Forager-Traders in South and Southeast Asia: Long-Term Histories*: 167–184, ed. K. D. Morrison and L. L. Junker. Cambridge: Cambridge University Press.

DOELMAN, TRUDY, NINA KONONENKO, VLADIMIR POPOV, GLENN SUMMERHAYES, ROBIN TORRENCE, ROBERTO BONETTI, ALESSANDRA GUGLIEMMETTI, ALBERTO MANZONI, AND MASSIMO ODDONE

- 2004 Acquisition and movement of volcanic glass in the Primorye Region of Far Eastern Russia. *Russia and the Pacific* 46:112–125.

DOELMAN, TRUDY, ROBIN TORRENCE, VLADIMIR POPOV, MIHAIL IONESCU, NICKOLAY KLUYEV, IGOR SLEPTSOV, IRINA PANTYUKHINA, PETER WHITE, AND MARK CLEMENTS

- 2008 Source Selectivity: An Assessment of Volcanic Glass Sources in the Southern Primorye Region, Far East Russia. *Geoarchaeology*: 243–273.

ELSTON, ROBERT G.

- 1990 A cost-benefit model of lithic assemblage variability, in *The Archaeology of James Creek Shelter*: 153–163, ed. R. G. Elston and E. E. Budy. Salt Lake City: University of Utah Anthropological Papers No. 13, University of Utah Press.

ELSTON, ROBERT G., AND P. JEFFREY BRANTINGHAM

- 2002 Microlithic technology in Northern Asia: A risk-minimizing strategy of the Late Paleolithic and Early Holocene, in *Thinking Small: Global Perspectives on Microlithization*: 117–131, ed. R. G. Elston and S. L. Kuhn. Arlington: Archaeological Papers of the American Anthropological Association No. 12, American Anthropological Association.

GOEBEL, TED

- 1999 Pleistocene human colonization of Siberia and the peopling of the Americas: An ecological approach. *Evolutionary Anthropology* 8(6):208–227.
- 2002 The “microblade adaptation” and recolonisation of Siberia during the Late Upper Pleistocene, in *Thinking Small: Global Perspectives on Microlithization*: 117–131, ed. R. G. Elston and S. L. Kuhn. Arlington: Archaeological Papers of the American Anthropological Association No. 12, American Anthropological Association.

HISCOCK, PETER

- 1994 Technological responses to risk in Holocene Australia. *Journal of World Prehistory* 8(3):267–292.

JUNKER, LAURA L.

- 2002 Economic specialization and inter-ethnic trade between foragers and farmers in the pre-hispanic Philippines, in *Forager-Traders in South and Southeast Asia: Long-Term Histories*: 203–242, ed. K. D. Morrison and L. L. Junker. Cambridge: Cambridge University Press.

KOBAYASHI, TATSUO

- 1970 Microblade industries in the Japanese Archipelago. *Arctic Anthropology* (7)2:38–58.

KONONENKO, NINA A.

- 2003 Three traditions of stone industry with the Zerkalnaya River Complex, in *Foraging Population of the Sea of Japan During the Late Pleistocene–Early Holocene*: 113–123, ed. A. Derevianko and N. A. Kononenko. Novosibirsk: Izdatelbstvo Institute of Archaeology and Ethnography.

KOROTKY, ALEXEY M., NINA A. KONONENKO, AND HIROSHI KAJIWARA

- 2003 Environmental and ecological characteristics of the Zerkalnaya Basin, in *Foraging Population of the Sea of Japan During the Late Pleistocene–Early Holocene*: 36–74, ed. A. P. Derevianko and N. A. Kononenko. Novosibirsk: Izdatelbstvo Institute of Archaeology and Ethnography.

- KUZMIN, YAROSLAV V., AND VALDIMIR K. POPOV, EDS.
 2000 Vulkanicheskie stekla Dalnego Vostoka Rossii: geologicheskie i arkeologicheskie aspekty [Volcanic Glass in the Russian Far East: Geological and Archaeological Aspects]. Vladivostok: Geological Institute, Far Eastern Branch of the Russian Academy of Sciences.
- LU, D. L.
 1998 The Microblade Tradition in China: Regional Chronologies and Significance in the Transition to Neolithic. *Asian Perspectives* 37(1):84–112.
- MORRISON, KATHLEEN D.
 2002 Pepper in the hills: Upland–lowland exchange and the intensification of the spice trade, in *Forager-Traders in South and Southeast Asia: Long-Term Histories*: 105–128, ed. K. D. Morrison and L. L. Junker. Cambridge: Cambridge University Press.
- NELSON, MARGARET C.
 1991 The study of technological organisation, in *Archaeological Method and Theory* 3:57–100, ed. M. B. Schiffer. Tucson: University of Arizona Press.
- ODELL GEORGE
 2004 *Lithic Analysis*. New York: Kluwer Academic/Plenum Publishers.
- SEONG, CHUNTAEK
 1998 Microblade technology in Korea and adjacent Northeast Asia. *Asian Perspectives* 37(2):245–278.
- SMITH, JASON W.
 1974 The northeast Asia–northwest and American microblade tradition. *Journal of Field Archaeology* 1(3–4):347–364.
- TORRENCE, ROBIN
 1989 Re-tooling: Towards a behavioural theory of stone tools, in *Time, Energy, and Stone Tools*: 57–66, ed. R. Torrence. Cambridge: Cambridge University Press.
- TYKOT, ROBERT H.
 2003 Determining the source of lithic artifacts and reconstructing trade in the ancient world, in *Written in Stone: The Multiple Dimensions of Lithic Analysis*: 59–85, ed. P. N. Kardulias and R. W. Yerkes. Maryland: Lexington Books.
- YESNER, DAVID R., AND GEORGES PEARSON
 2002 Microblades and migrations: ethnic and economic models in the peopling of the Americas, in *Thinking Small: Global Perspectives on Microlithization*: 133–161, ed. R. G. Elston and S. L. Kuhn. Arlington: Archaeological Papers of the American Anthropological Association No. 12, American Anthropological Association.

ABSTRACT

The purely typological approach to microblade technology often obscures the range of variability seen in the creative and flexible ways microblade cores were prepared and the reasons behind this variability. There is a real need to understand the situational context of microblade production and move the focus of investigation on to the microblades themselves, as these are the key components of an effective risk-reduction strategy. Combining a typological and technological approach to study standardization in core preparation and the resulting microblades made from volcanic glass within a known geological context has shown that key characteristics of both are vital to the successful implementation of this technological approach. KEYWORDS: microblade technology, typology, risk, volcanic glass, Far East Russia.